Monthly Report

August 2001

Contract Number: NAS5-98076

HALOE Algorithm Improvements for Upper Tropospheric Soundings

1. Summary

General Approach

The goal of this work is to extend the HALOE retrievals into the troposphere. The approach is to begin with the current (Version 19) HALOE data, improve and correct them where necessary, combine them in a sensible fashion and retrieve the mixing ratios to lower altitudes than previously possible. The specific tasks necessary for this and current work towards their completion are detailed in Section 2.

Overview of Previous Work

We continued to make small improvements in our tropospheric water retrievals that utilize the HF DV/V signals. We increased the resolution of the lower portions of the CH_4 and HF retrievals that provide interferrent profiles of these gases needed in the DV/V water retrievals. The CH_4 profile can now be better characterized with the finer grid spacing and this results in an improved roll off to 1.7ppmv in the troposphere. Likewise, doing a high resolution HF retrieval near the tropopause allows the retrievals to better match the HALOE HF DV/V signals. These changes have resulted in improved accuracy and reliability of the H_2O retrievals in the troposphere.

Other topics that we investigated included a review of the HF V signal as a useful tool in cloud detection; we determined that while the HF V signal might be useful, it might also prove difficult to distinguish between thin cirrus and high tropospheric water. Our cloud detection routines are progressing; the latest version uses multi-wavelength extinctions combined with model predictions of HALOE response to identify clouds composed of ice, nitric acid trihydrate (NAT), and liquid ternary aerosols (LTA).

Lastly, we also examined very carefully the differences between the HALOE and simulated signals in the DV water retrievals. In the retrievals, the HALOE and simulated DV/V signals are matched as part of the retrieval process. The HALOE and simulated DV and V signals, however, in some cases are very different. We believe that these modeling problems ratio out in the DV/V signal formulation and our DV/V retrievals remain quite accurate.

Accomplished This Month

We began work on the report covering the third year of the contract. We are reviewing the work performed over the last year and are summarizing those results. As part of this review, we are

describing all the improvements we have made and how those improvements would be reflected in a Version 20 software release. V20 would include a tropospheric water product obtained using the HF DV/V water retrieval, better H_2O and NO_2 retrievals due to model improvements, as well as improved gas correlation channel retrievals. We examined in detail the possible sources of the differences between the HALOE and simulated V signals used in the DV/V water retrieval. While the cause remains unknown, the DV/V water retrievals appear to be unaffected which is an indication that the signal formulation ratios out any such problems.

Our efforts in developing a more robust cloud detection scheme are underway. We have modified our approach to incorporate new model spectra for NAT and LTA. Calculations are underway to compare the new model to HALOE measurements. We have written a paper discussing our NAT and LTA work that was submitted to GRL this spring. We are currently rewriting the paper to address the comments made by the reviewers.

Plans for Future Work

We will finish the contract report in which we discuss in depth the improvements that we have implemented in the HALOE level 2 software suite. We will outline the benefits to the science community that would result from a reprocessing of the HALOE data using the new software. We may add a few final improvements to the V20 algorithm.

Problems Encountered

None

2. Description of Work, Itemized by Objective

a. Pointer Tracker Error Estimates and Correction

No significant current work

b. Cloud/Aerosol Characterization and Identification

The HALOE cloud detection scheme is under development. The original cloud model spectra were based on a synthetic range of NAT and LTA size distributions. The model results were the basis for developing extinction ratio signatures that can identify ice, NAT, and LTA from HALOE measurements. This approach was challenged by comparing with model results based on a long-term record of in situ size distribution measurements in NAT and LTA PSCs. These results show that the original NAT and LTA extinction ratio curves should encompass a broader range of values. The new model spectra were incorporated into the cloud detection algorithm. The HALOE results are being compared to thermodynamic model predictions of NAT and LTA properties in and near the tropical tropopause. These calculations are being compared to HALOE measurements to validate the HALOE results and test the model capabilities.

A paper describing the HALOE measurements of NAT and LTA clouds near the tropical tropopause was submitted to GRL earlier this spring. The reviews of this paper were received, and the paper is currently being modified to reflect the reviewer comments.

c. Simultaneous Multichannel Inversion Algorithm

We ran several sweeps to test the new water products added to the level 2 final product. The two new water products are the HF DV/V water retrieval and a merged water profile composed of the combined H_2O V and HF DV/V profiles. The testing uncovered a few algorithm bugs, which were easily fixed. The routine that merges the two water retrievals is not very sophisticated and future refinements could prove useful.

We studied the differences in the HALOE and simulated V signals that arise during in the CH_4, HCl, and HF DV/V retrievals. The signal differences are normally not noticed since the retrievals match the DV/V signal. Because the CH_4 and HCl V signals can be used to retrieve methane, we examined the possible sources of the differences, as they are a likely cause of our difficulties in retrieving methane using either the CH_4 or HCl V signals. Possible reasons include errors in extrapolating the aerosols from the NO channel and not modeling the solar source function correctly. We were not able to determine the reason for the differences, but we should point out they we believe that model problem, whatever its source, ratios out in the DV/V signal formulation and is not impacting our DV/V retrievals.

d. Forward Model Improvements

No significant current work

e. High Resolution Gas Channel Retrievals

No significant current work

f. Improved Temperature Retrieval

No significant current work

g. Robust Error Estimates

No significant current work

h. Long Term Trend Reliability Studies

No significant current work

i. Data Validation

The consistency checks on the HALOE data continue. These include: examination of instrument/geometry dependencies such as beta angle, internal temperatures, and doppler velocity; sunrise-sunset differences; inter-comparison of Versions 18, 19, and 20; and correlative measurement comparison.

3. Contributors

Earl Thompson	thompson@gats-inc.com
Marty McHugh	mchugh@gats-inc.com
Larry Gordley	gordley@gats-inc.com
Jim Russell	jmr@cs.hamptonu.edu
Mark Hervig	hervig@trex.uwyo.edu
Tom Marshall	tom@gats-inc.com
Anju Shah	shah@gats-inc.com

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Robert E. Thompson

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GATS, Inc.
11864 Canon Boulevard, Suite 101
Newport News, Virginia 23606

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14. ABSTRACT

This report details the ongoing efforts by GATS, Inc., in conjunction with Hampton University and University of Wyoming, in NASA's Mission to Planet Earth UARS Science Investigator Program entitled "HALOE Algorithm Improvements for Upper Tropospheric Sounding." The goal of this effort is to develop and implement major inversion and processing improvements that will extend HALOE measurements further into the troposphere. In particular, 0_3, H_20, and CH_4 retrievals may be extended into the middle troposphere, and NO, HCl and possibly HF into the upper troposphere. Key areas of research being carried out to accomplish this include: pointing/tracking analysis; cloud identification and modeling; simultaneous multichannel retrieval capability; forward model improvements; high vertical-resolution gas filter channel retrievals; a refined temperature retrieval; robust error analyses; long-term trend reliability studies; and data validation. The current (first year) effort concentrates on the pointer/tracker correction algorithms, cloud filtering and validation, and multichannel retrieval development. However, these areas are all highly coupled, so progress in one area benefits from and sometimes depends on work in others.

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